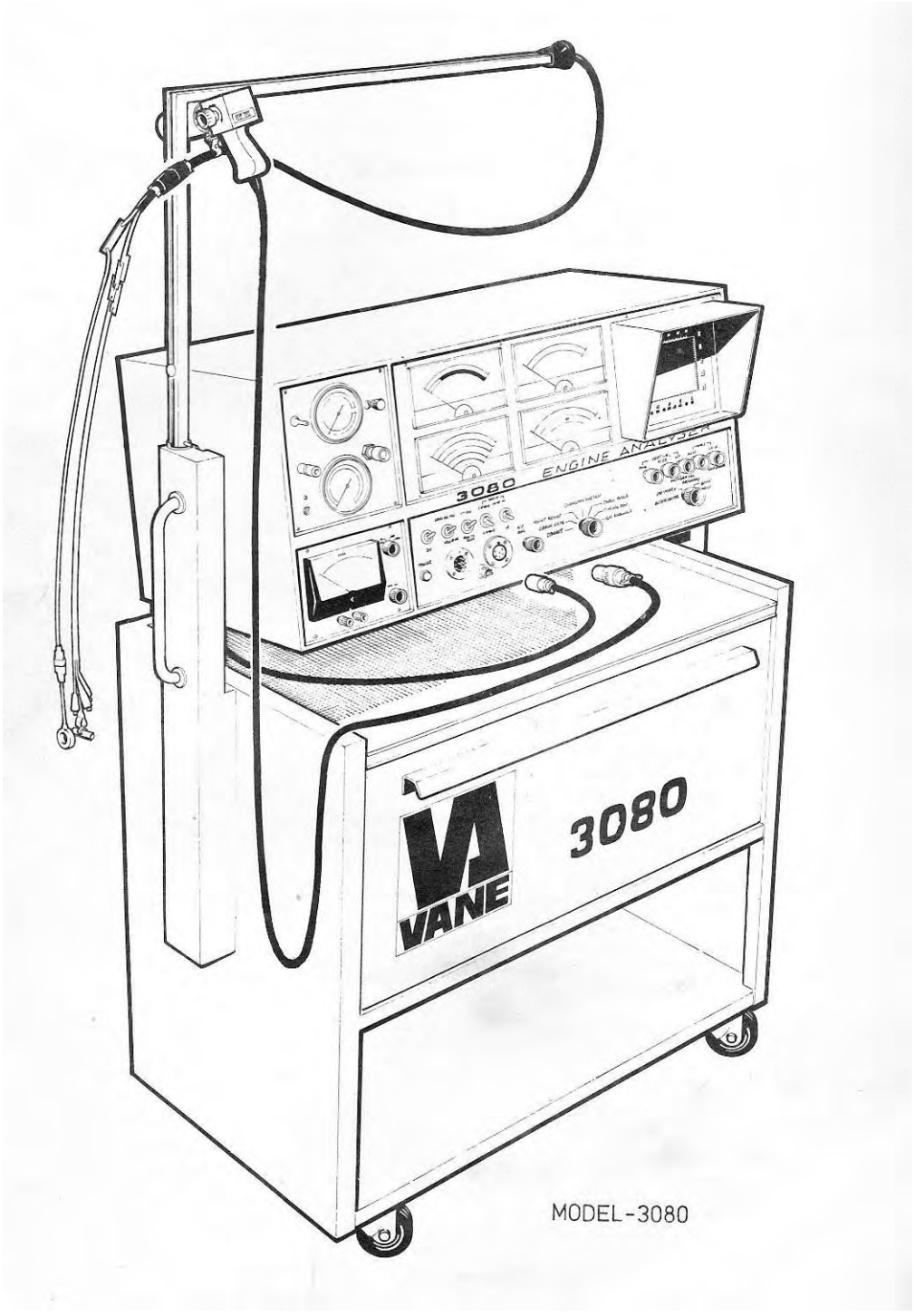
3080 ENGINE ANALYSER



OPERATING MANUAL

VANE

Authorised service centres for **VANE INSTRUMENTS** are located in most major cities and many country areas.
For the address of the Vane Service Centre in your locality, check the list packed with your instrument, or consult your local Vane Distributor.

VANE INSTRUMENTS
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INTRODUCTION

This Analyser presents a complete tune up system in a single cabinet and has been primarily designed to provide a logical and practical series of tests which, when carried out in the correct sequence, will cover a complete analysis of each of the following:—

CYLINDER LEAKAGE

BATTERY CONDITION

PRIMARY WIRING

DISTRIBUTOR POINT CONDITION

DISTRIBUTOR DWELL ANGLE

DISTRIBUTOR AUTOMATIC ADVANCE

IGNITION TIMING

VOLTAGE REGULATOR SETTING

ALTERNATOR OR GENERATOR CONDITION

COIL POLARITY AND OUTPUT

SCOPE ANALYSIS OF COIL, CONDENSER AND H.T. CIRCUITS

FUEL PUMP PRESSURE

MANIFOLD VACUUM

CARBURETTOR CALIBRATION

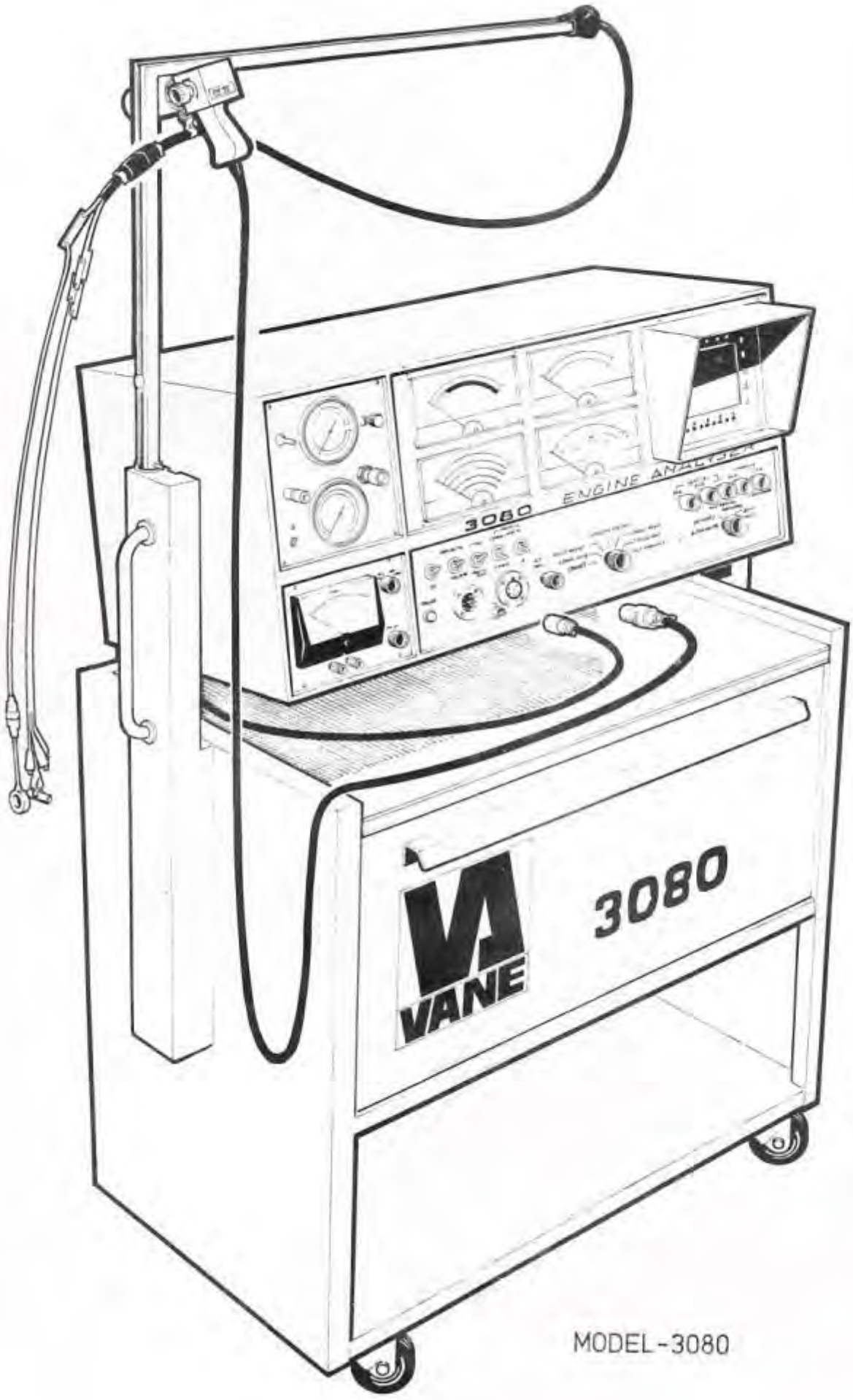
The instrument is self contained and operates from any earthed 220-240V 50 c.p.s. power outlet.

IMPORTANT

THE INFORMATION AND SEQUENCE OF TESTING PROCEDURES OUTLINED IN THIS MANUAL IS THE RESULT OF CONSIDERABLE TIME AND THOUGHT.

WHEN TESTING RESIST THE TEMPTATION TO TAKE "SHORT CUTS". THIS CAN ONLY LEAD TO WASTE OF YOUR TIME, INCORRECT DIAGNOSIS AND CUSTOMER DISSATISFACTION.

CONTENTS



MODEL-3080

CONTROL FUNCTIONS

To give the user a better understanding of this instrument a list of the controls is tabulated below, together with each functional purpose.

1. MAIN SELECTOR SWITCH

The test required is selected by this switch. The switch positions are in a progressive sequence so tuning is carried out in this fashion, with reference to the various steps explained in this book satisfactory results must follow.

Controls listed 2 to 6 are grouped to the left of the Main Selector Switch.

2. POWER SWITCH

Controls the 240V supply to the instrument. "ON" position is indicated by the pilot light.

3. GROUND POLARITY

This switch is set to match the Battery Earth Polarity of the vehicle being tested.

4. POINT RESISTANCE

This switch converts the Voltmeter to a low range, which is used for taking Voltage Drop readings, primarily in the earthing side of the ignition low tension circuit.

5. TACHO SWITCH

Selects the R.P.M. range, either 0-2000 or 0-8000.

6. 2 STROKE/4 STROKE SWITCH

Alters the Tacho. Range and Advance Scale for the type of engine. It is used in the 2 Stroke position for Wankel engines.

7. A/F BALANCE

To bring Air/Fuel Ratio meter needle over "BALANCE" on the scale.

The controls grouped to the right of the Main Selector Switch are all related to the 'Scope and their functions are as follows.

8. PATTERN SELECTOR

Selects the type of pattern required for particular testing.

9. VERTICAL POSITION

This control shifts the whole pattern on the screen upwards or downwards as required.

10. VERTICAL SIZE

Increases or decreases the vertical size of the signal oscillations.

11. VERTICAL HEIGHT

This control spreads the pattern vertically for separately viewing the patterns from all cylinders or superimposing the patterns one on top of each other.

12. LINE START

The position of the left edge of the pattern is controlled by this knob. It is used to move the pattern horizontally.

13. LINE LENGTH

Compensation for changes in engine speed are made with this control. The pattern may also be expanded horizontally for examination in detail of any portion of the ignition cycle.

14. In the rear of the instrument are three controls labelled FOCUS, BRIGHTNESS and ASTIGMATISM. These controls are used to set the 'scope to suit ambient light conditions and need not normally be touched.

ADDENDUM

REFERENCE FIG. 4

Should the Timing Light and Tachometer be erratic in operation the following step should be taken to stabilise the operation of the instrument.

Remove the No. 1 plug lead from the spark plug and pass it through the pick-up ring twice. If the lead is too short extend it by using the extension spark plug lead supplied.

This will increase the strength of the synchronising pulse applied to the instrument.

N.B. This will only be necessary with low output ignition systems.

CONNECTING THE LEADS

N.B. PLUGS WILL ONLY FIT ONE WAY.
DO NOT FORCE THEM!

The main lead which is assembled into the boom arm is plugged into the left-hand socket, the timing light into the right-hand socket. The engine harness is then plugged into the socket at the end of the main lead, care being taken to match the key with the key-way.

WARNING. The timing light must be plugged into the panel whenever the instrument is being used.

Plug unit power lead into 220 — 240V 50Hz power outlet and switch "ON".

CONNECTING SEQUENCE

Each lead has its own identity tag.

Attach clip on main lead to a convenient spot on or near the bonnet, ensuring that when individual leads are connected they will be clear of fan, pulleys or exhaust manifold.

1. Turn Main Selector Switch to CONNECT position.
2. Select correct POLARITY.

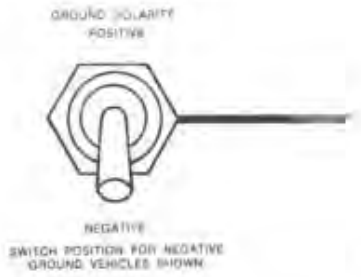


Figure 1

3. Connect GROUND lead to a clean bolt head preferably at rear of the engine.
4. Connect LIVE BATTERY lead to the battery terminal from which the vehicle electrical supply is taken. Ref. Fig. 2.

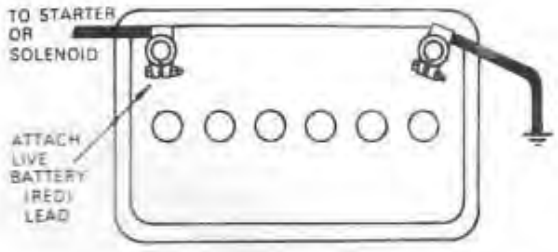


Figure 2

5. Connect BREAKER POINTS lead to the DISTRIBUTOR primary terminal of the coil. Ref. Fig. 3.

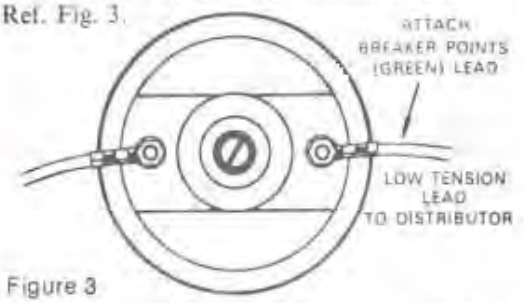


Figure 3

6. Remove the H.T. lead from No. 1 spark plug, thread it through the ring attached to the end of No. 1 plug lead and replace the lead on the spark plug. Refer Fig. 4.

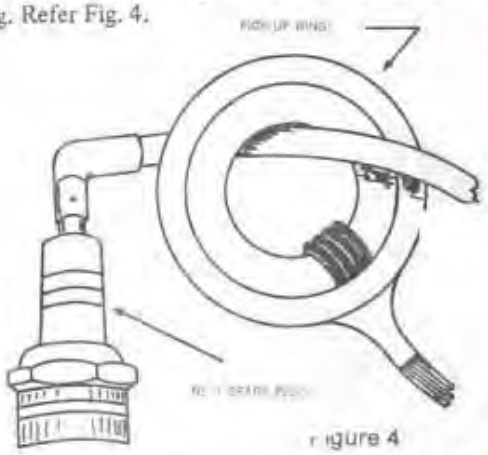


Figure 4

7. Attach the IGN. OUTPUT load clip around the H.T. lead fitted between the coil and the distributor. Refer Fig. 5.
For best performance attach the clip centrally between the coil and distributor.

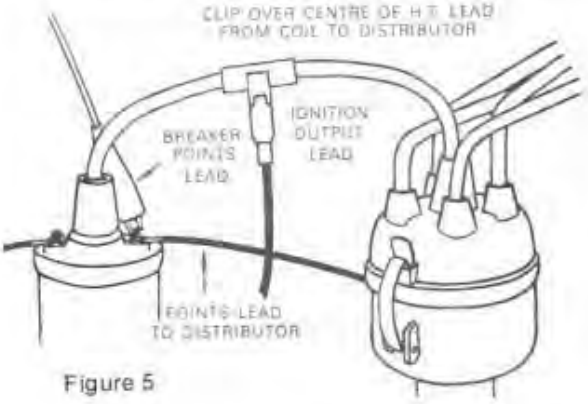


Figure 5

8. Connect Vacuum Gauge to inlet manifold. Do not connect to distributor vacuum line as this is not true manifold vacuum.

9. Should it be necessary to use the ammeter, the lead for this is plugged into the socket below the two other sockets on the panel. The shunt is connected in series with the "B" terminal on the voltage regulator for charging circuit amperage.

   The ammeter circuit is of fixed polarity which means that the polarity switch on the panel has no affect on it. Therefore should the meter read in reverse it will be necessary to reverse the shunt connection.

   N.B. THIS IS ONLY APPLICABLE TO GENERATOR SYSTEMS. NEVER ATTEMPT TO CONNECT SHUNT TO REGULATOR ON AN ALTERNATOR EQUIPPED VEHICLE.

   For any other ampere readings the shunt is connected in series with the circuit to be checked.

10. Turn on POWER switch.

USING THE OHMMETER

This particular instrument function is self-contained and may be used at any time.

It has four ranges:- 10, 100, 1000 and 10000 ohms centre scale. Select the range required, hold both clips together and using the OHMS ZERO control bring the meter needle over O graduation at right of scale. Then place component in series with the leads and read resistance.

N.B. If needle will not zero, it will be necessary to replace the batteries. The holder for these is seen under OHMS ZERO control and is opened with a screwdriver. Observe polarity when replacing.

INSTRUMENT FAMILIARISATION

The notes set out hereunder list a description of the main switch positions, with the combination of leads used in each position.

Additional tests other than those specifically connected with tuning can be made and although some are mentioned other tests can be carried out as the operator becomes more familiar with the possibilities of this instrument.

A study of these features will make for a better understanding of its capabilities so that its versatility may be fully exploited and its employment in diagnosis and correction becomes second nature to the operator.

MAIN SWITCH POSITIONS

1. CONNECT. A fully neutral position.
   All circuits in the instrument are immobilised, with all leads attached to the various points on an engine and the 240V power supply switched on. Neither power supply nor battery voltage is being used.

2. CRANKING VOLTS. The LIVE BATTERY (red) lead, in conjunction with the GROUND (black) lead, gives the voltage readings.
   The BREAKER POINTS (green) lead shorts out the ignition primary circuit. In this switch position and with the green lead attached to the distributor side of the coil the engine will not start.

   Should the engine start during the test in this switch position, the Green lead is attached to the wrong terminal of the coil, and should be changed over.

   Any voltage readings within the range of the instrument scale can be taken by using the RED and BLACK leads; providing always that the correct polarity is selected on the GROUND POLARITY switch.
   The Black lead must be used as the Ground lead and the Red lead as the "working" or "searching" lead.
   Voltage at the lights, wiper motor, etc., may be checked in this manner.

3. POINTS RESISTANCE. For this particular check, the BREAKER POINTS (GREEN) lead is being used with the GROUND (BLACK) lead. The 20 volt scale is expanded to a I volt full scale range by depressing the switch marked POINTS RESISTANCE. The two main functions of this expanded voltage scale are for checking voltage loss in both the primary ignition circuit and the earth return circuit, both these checks being fully outlined in a later section.

4. CHARGING SYSTEM. If the vehicle is alternator equipped, the PATTERN SELECTOR switch should be turned to ALTERNATOR and the VERTICAL SIZE control turned fully clockwise.
   Previous remarks concerning the use of the voltmeter are applicable also to this switch position and again the RED and BLACK leads are used for this purpose. Amperage readings are shown and are transmitted by the double lead which terminates in a "shunt". Apart from the normal usage outlined later in this book, the amperage draw of a component may be measured by connecting the "shunt" in SERIES

with the wire feeding that component.

N.B.: The starter cannot be checked with this "shunt", and it will be seen that the AMPS scale only reads to 100 and starter draw is well in excess of this figure.

To check amperage draw at, say, the lights, it is only necessary to disconnect the wire for the appropriate beam and insert the "shunt" in series. As soon as the lights are switched on the amperage draw will register on the meter.

5. DWELL ANGLE. In this switch position both TACHO and DWELL ANGLE readings are shown. The TACHOMETER has two scales, 0 — 2,000 R.P.M. (top scale), selected by TACHO switch in LO position, 0 — 8,000 R.P.M. (bottom scale), selected by TACHO switch in HI position.

   DWELL ANGLE readings are taken from the scale which bears the cylinder designation for the vehicle being worked on. No switching is necessary to compensate for the number of cylinders. The important thing to remember is that the scales read from RIGHT to LEFT.
6. TIMING ADVANCE. This switch position is used for setting initial timing and checking both centrifugal and vacuum ignition advance curves. The procedure is fully outlined in Sixth Area Test. The control for actuating the advance checking circuit is on the timing light as is the "ON-OFF" switch. Readings are taken from the scale labelled "IGNITION ADVANCE-ENGINE DEGREES" The tachometer is also working in this switch position.
7. IGNITION ANALYSIS. Switching to this position brings in the oscilloscope, or to use its abbreviated name — 'scope. The IGNITION OUTPUT pick-up is very sensitive to the secondary circuit voltages in the H.T. lead between the coil and the distributor. Many factors influence the strength and duration of the secondary voltage; these voltage changes are sensed by the pick-up and appear on the 'scope as changing patterns. To enable the operator to vary the picture so the most advantageous presentation may be obtained, there is a separate set of controls for the 'scope. These are found under the 'scope and their action is described hereunder.

PATTERN SELECTOR

This switch selects the type of pattern. The type of pattern selected has a specific viewing purpose for various ignition components and reference to SEVENTH AREA test and the accompanying patterns will clarify the position used to check a given component.

VERTICAL POSITION

Moves the picture up or down, to either centralise the patterns, or check the distributor cam. This cam may be checked for wear, bent shaft, etc., on the appropriate cylinder degree scale at the bottom of the screen.

VERTICAL SIZE

(Operative with PATTERN SELECTOR switch in PRIMARY and SECONDARY positions). Controls the height of the various oscillations in the pattern, so if desired an enlargement of the trace may be obtained to assist in diagnosis.

VERTICAL HEIGHT

(Operative ONLY with PATTERN SELECTOR SWITCH in SECONDARY position). Will spread the individual cylinder traces so all cylinders will appear one under the other. They may also be brought together, all on top of each other, presenting a single trace, or as it is called superimposed. With the spread pattern, the trace at the top of the screen is No. 1 cylinder, the next one down being the next cylinder in firing order. In a six cylinder presentation, therefore, the top trace being No. 1, the traces in descending order will be 1, 5, 3, 6, 2, 4.

LINE START

Enables the picture to be moved from one side of the screen to the other, again to either centralise the picture or to bring a particular section to a better viewing position.

LINE LENGTH

As implied, either lengthens or shortens the traces so that a particular portion may be more closely examined.

It will be seen that all the control knobs are marked with a white dot. As the preliminary step towards setting the picture on the screen, place all the white dots at 12 o'clock. This will put the picture on the screen and then, by adjusting the controls as necessary, the individual traces may be placed one under the other, the left hand end of the trace in line with the left vertical white line and the right hand end in line with the right hand vertical white line. The vertical position of the picture should be such that all traces with a spread pattern, are between the top and bottom horizontal white lines without running into them, nor should the individual oscillations run into each other.

It is suggested that the operator connects and runs the instrument, working the various controls to thoroughly familiarise himself with their actions.

Remember, that the engine to which the instrument is connected should be running at 1500 R.P.M. Do not, at this stage, attempt to interpret any faults that may show — "just fiddle". The ideal situation is reached when the operator can change the picture without reference to the labels. The VOLTAGE picture should have the heavy horizontal trace lined up with the bottom horizontal white line connecting the two KILOVOLT scales which are seen on either side of the screen. This will enable an accurate reading to be taken of the vertical voltage pulses against the scale selected on the PATTERN SELECTOR.

The 20KV scale is used to check plug firing voltage and rotor gap voltage.

The 40KV scale is used mainly for checking the open circuit voltage of the coil.

Any individual pulse may be brought closer to the actual scale by rotating the LINE START CONTROL.

VACUUM/FUEL PUMP PRESSURE GAUGE

This gauge is often overlooked as an aid in the diagnosis of actual mechanical faults affecting an engine. Any faulty engine part which will lower compression pressure, must also lower manifold vacuum, and with this gauge connected into the inlet manifold, any such malfunction may be pin-pointed by the type of needle fluctuation on the gauge. Factors other than those which will lower compression pressure, can also affect vacuum readings, these factors again showing in the type of needle fluctuation or needle position.

As with the 'scope, a "fiddle" period is recommended and will be most beneficial, particularly if faults are deliberately introduced and their symptoms noted.

The aim in corrective work using this gauge is to obtain the highest, steady, reading. The exception to this is the setting of IGNITION TIMING.

With present-day compression ratios, it is possible to advance the timing, so a steady, high reading is obtained, but if checked with the timing light, it could well be over-advanced.

Apart from the readings obtained with the gauge connected into the inlet manifold, alternate readings may be obtained by connection to the vacuum unit of the distributor; and to both inlet and outlet sides of the petrol pump.

When used on the distributor vacuum unit, it is suggested that a Y piece be inserted in the vacuum line between the carburettor and this unit, and the vacuum gauge be connected to a leg of the Y. The vacuum unit will still work and the amount of "pull" will be noted on the gauge. If used in this fashion, in conjunction with the "TIMING ADVANCE" main switch position of the instrument, the degrees of advance for a given vacuum may be accurately checked against specifications.

Fuel pump pressure may be checked by disconnecting the main feed line, either at the carburettor or the pump, and connecting the gauge line into the pump, or onto the main feed line. There is generally sufficient petrol in the carburettor bowl to start and idle the engine for about half a minute, and as the pressure is the same at idle as at speed, that is all that is needed.

Fuel pump vacuum may be checked in the same manner by connecting to the inlet side of the pump.

It should be noted that true inlet manifold vacuum cannot be obtained by connection to the distributor vacuum unit line.

The take-off for this line is above the carburettor throttle plate or "butterfly" and as such the readings can vary quite considerably from those existing in the manifold proper.

Altitude has a definite effect on vacuum gauge reading, e.g. an engine which will pull 20 ins. Hg at sea-level, will only pull 18 ins. Hg at 2000 ft. The figure of 1 in. Hg drop at 1000 ft. is constant and allowance for this should be made when diagnosing or tuning.

VACUUM DAMPER

This control is used to reduce fluctuation on 2 and 4 cylinder engines at low speed. Too much damping can interfere with analysis of vacuum faults, it should be applied with discretion.

VACUUM GAUGE READINGS

DARK NEEDLE INDICATES STEADY HAND

LIGHT NEEDLE INDICATES FLUCTUATING HAND

Normal Motor

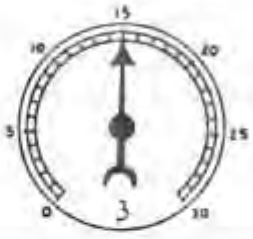
Hand steady between 17 and 21

IDLE

Norma or

Opening and closing throttle rapidly. Rings and valves O.K.

Poor Rings or Oil



Hand steady but lower than normal

2,000 RPM

Poor Rings or Oil

Opening and closing throttle rapidly. Hand pulls down to zero

Sticky Valve

Hand drops occasionally about 4 divisions

3,000 RPM

Burnt Valve

Hand drops regularly several divisions

3000 RPM

Leaky Valve

Hand drops 2 or more divisions when valve should close

3,000

Loose Valve Guides

Fast vibration of hand between 14 and 19

3000 RPM

Weak Valve Springs

Motor racing, hand registers 10 to 22. Wider variations as speed is increased

4000 RPM

Late Valve Timing

Hand reads from 8 to 15 and remains steady

ANY SPEED

Late Ignition Timing

Hand reads from 14 to 17 and remains fairly steady

ANY SPEED

Plug Gaps too Close or Points not Synchronized

Hand floats slowly between 14 and 16

ANY SPEED

Leaky Intake or Carburetor Gasket

Hand reads below 5

ANY SPEED

Leaky Head Gasket Between Cylinders

Hand floats regularly between 5 and 19

ANY SPEED

Choked Muffler

High reading at first. Breaks to 0 and builds back slowly to about 16

3000 RPM

Carburetor Out of Adjustment

Hand floats slowly between 13 and 17

IDLE

BATTERY AND INSULATED STARTER CIRCUIT

MAIN SWITCH IN "CRANKING VOLTS" POSITION

The object of this test is to determine:

A. If the battery is capable of meeting the demand made on it with the starter in operation.
B. If the starter operates satisfactorily.
C. If the cables, starter switch, and earthing are in good condition.

TEST A

Operate starter for approximately 10 seconds and read voltage after meter hand steadies, and with starter still turning the engine.

Reading should not drop below 4.5 volts for a 6 volt system or 9 volts for a 12 volt system.

NOTE: Engine will not start with main switch in this position, so that normal "Key-start" may be used for cranking.

If battery is in good condition it should recover to a "no-load" minimum reading of 11.6 volts after this test.

TEST B

This is determined by ear, when it should be noted whether the starter operates at a satisfactory speed.

TEST C

Remove LIVE BATTERY lead from battery and attach to main armature terminal on starter. Ref. Fig. 6.

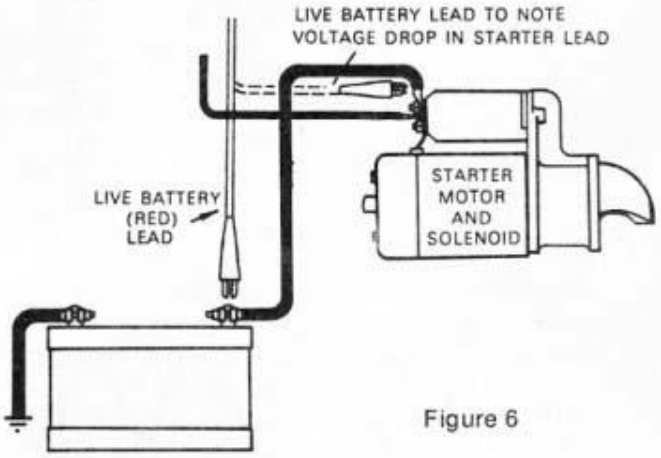


Figure 6

Engage starter and read voltage whilst operating. Reading should be within .3 volt of reading obtained at battery.

E.G.: If the load voltage at battery was 10.3 — voltage at starter should not be less than 10 volts.

*This test is only necessary if TEST B is unsatisfactory.

ADDITIONAL TEST

EARTH RETURN CIRCUIT

MAIN SWITCH IN POINTS RESISTANCE POSITION

The object of this test is to determine the voltage drop in the earth return circuit.

This test is particularly important where the battery of a vehicle is earthed to the body, which means that the engine then has to be earthed to the body also.

The GROUND lead is attached to that terminal of the battery which is earthed.

The BREAKER POINTS lead is attached to a good earth on the starter, possibly a "through-bolt".

Ground the distributor points, or pull out the H.T. lead from the coil, as in this Main Switch position the engine will start.

Crank engine with the starter at the same time press the POINTS RESISTANCE switch.

The reading is taken from the POINTS RESISTANCE scale and should not be outside the GOOD zone.

If the reading is in the "BAD" zone, move the BREAKER POINTS lead and attach it to a clean earth on the engine, then repeat the test. Should the reading now be in the "GOOD" zone, it indicates that the starter is not properly earthed to the engine block. A reading still in the "BAD" zone indicates that the engine is not properly earthed to the body or that the body is not earthing correctly to the battery.

The GREEN lead may be attached to a clean portion of the body and the test repeated, so that a faulty earth connection between the battery and body can be revealed.

TROUBLE SHOOTING

	Sympton	Possible Cause
TEST A	Battery voltage low. Low cranking speed.	Discharged or defective battery. Voltage regulator setting too low.
TEST C	Voltage at starter low.	Dirty battery terminals.
	Low cranking speed.	Dirty connections at starter, or starter switch. Poor connections inside solenoid. Faulty battery earth strap. Faulty engine/body earth strap.
	Low cranking speed with voltage at battery and starter normal.	Defective starter.

CRANKING VACUUM

The object of this test, which is done in conjunction with the "CRANKING VOLTS" test is to determine the mechanical condition of the engine, in other words to determine its acceptability for further tuning work.

It will be necessary to adjust the vacuum damper control on the instrument to even out the pulses, particularly on four cylinder vehicles.

Readings will vary from engine to engine depending on mechanical characteristics, but individual cylinder readings should be even.

Several points should be noted relative to this test:-

1. Check that automatic choke is not holding throttle on the fast idle ramp.
2. Check that idle speed adjustment screw is set well back.
3. On vehicles equipped with P.C.V. a truer reading will be obtained if the hose is blocked off.

Any marked discrepancy in individual cylinder readings is indicative of mechanical wear or maladjustment and this should be determined by a "CYLINDER LEAKAGE TEST".

CYLINDER LEAKAGE TEST

Cylinder leakage testing will show intake and exhaust valve leakage, leakage between cylinders or into the water jacket, or any other cause of compression loss. Even small leaks can easily be detected.

IMPORTANT

Careful preparation is the key to successful cylinder leakage testing and will help to avoid 'misleading results.

PREPARATION

1. Run the engine until normal operating temperature is reached.
2. Remove spark plugs, air cleaner, radiator filler cap and engine oil filler cap.
3. Block throttle in the wide open position.
4. Top up the cooling system to the correct level.
5. Connect GROUND lead to cylinder head bolt or other good earth. Connect BREAKER POINTS lead to distributor side of coil or distributor breaker points terminals. Turn the SELECTOR switch to POINTS RESISTANCE. Ground the coil H.T. lead.

CALIBRATION

1. Turn the PRESSURE REGULATOR knob on the right hand side of the gauge fully anti-clockwise.
2. Connect the air supply (70-150 lbs.) to the AIR connector.
3. Turn the PRESSURE REGULATOR knob clockwise until the gauge reads zero (full scale).

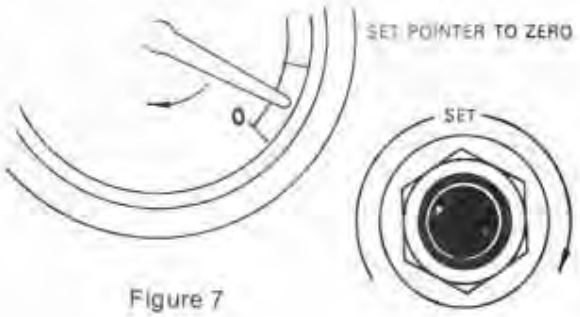


Figure 7

Connect and disconnect the test hose several times and re-adjust the regulator as necessary to maintain the zero reading.

This is the setting from which all tests are made and should be checked prior to testing each cylinder.

TEST PROCEDURE

1. Select the correct adaptor for the size and type of spark plug hole on the engine and screw it into No. 1 cylinder plug hole.
2. Turn on the ignition. Rotate the engine until the timing marks and distributor rotor position indicate T.D.C. compression stroke for No. 1 cylinder. At this position the Points Resistance meter will show an upscale reading as the distributor points open.

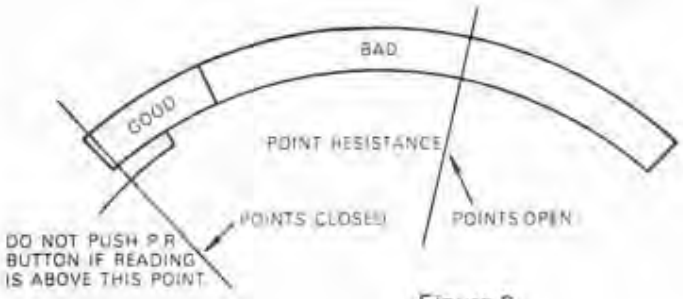


Figure 8

3. Connect the hose from the LEAKAGE connector on the instrument to the adaptor and read the percentage of leakage on the CYLINDER LEAKAGE gauge.
   Listen for escaping air through the carburettor, the exhaust pipe and the engine oil filler.
   Check for air bubbles in the radiator.
4. Disconnect the test hose from the adaptor, remove the adaptor and insert into the next cylinder in the engine firing order.
5. Rotate the engine until the Points Resistance meter needle falls towards zero and then rises again indicating that the piston is at T.D.C.
6. Repeat steps 3, 4 and 5 until all cylinders have been tested.
7. Switch off ignition.

TEST EVALUATION

All readings should be even and under 20 per cent.

Excessive leakage on any cylinder can generally be diagnosed as follows:-

Air escape through —

Carburettor: Inlet valve leakage, cracked valve seat. Incorrect tappet adjustment.

Exhaust: Exhaust valve leaking, cracked valve seat. Incorrect tappet adjustment.

Radiator: Cylinder head gasket or cracked head.

Oil filler: Worn piston rings or cylinders, cracked piston.

SECOND AREA

IGNITION PRIMARY CIRCUIT: BATTERY TO COIL

This test is used if the vehicle is hard to start, or if the ballast resistor or ignition switch are suspect.

MAIN SWITCH IN "CRANKING VOLTS" POSITION

The object of this test is to determine that the correct voltage is being delivered to the coil from the battery.

A. Under normal conditions.
B. Under starting conditions.

TEST A

Remove LIVE BATTERY (Red) lead from battery and attach to switch terminal on ignition coil.

Switch ignition ON.

ENSURE THAT DISTRIBUTOR POINTS ARE CLOSED.

Reading on voltage scale should be within .3 volt of the "no-load" voltage of the battery.

E.G.: Battery voltage without loading — 12.4 volts — voltage at coil should be 12.2 volts or above.

IMPORTANT NOTICE: Cars fitted with a ballast resistor in the primary circuit will give considerably lower readings than the example above. These readings should be checked against vehicle specifications.

TEST B

Without disconnecting LIVE BATTERY lead from coil, check voltage reading with starter in operation.

This reading should again be within .3 volt of the load voltage of the battery.

The load voltage was obtained in FIRST AREA Test, TEST A.

This applies to most vehicles fitted with a ballast resistor, as in the starting position of the ignition switch the ballast is by-passed allowing the available battery voltage into the coil to facilitate starting.

TROUBLE SHOOTING

If readings do not fall within those mentioned, it will be necessary to move the LIVE BATTERY lead from the coil and using it as a "searching" lead check back from the coil towards the battery. This is done with ignition on, distributor points closed and is a point by point search.

Each succeeding point will show a small gain, but when an acceptable reading is obtained the wire or point which has just been passed obviously is the one causing the voltage loss and must be either cleaned, tightened or replaced.

IGNITION PRIMARY CIRCUIT: FROM COIL TO EARTH THROUGH DISTRIBUTOR

MAIN SWITCH IN POINTS RESISTANCE POSITION

N.B.: DO NOT PRESS POINTS RESISTANCE SWITCH IF NEEDLE READS UPSCALE.

The objects of this test are:

A. To ensure continuity of primary current from the coil through the various connections of the distributor and finally to earth.

B. To ensure that all such joints and wires offer minimum resistance, or in other words that voltage loss is as low as possible.

NOTE:

Visually check the contact breaker points to make sure that there is sufficient metal. Points can show a satisfactory reading on the meter indicating good electrical contact even though they are practically worn out.

Visual inspection can also determine condenser efficiency.

If the condenser is working properly the contact surfaces of the points will have a grey frosted appearance.

TEST A

CONTACT BREAKER POINTS MUST BE CLOSED. IGNITION SWITCH ON.

The indication of circuit continuity is zero reading on the meter. If the needle reads upscale and will not return to zero even though the contact points are closed an open circuit is present which must be corrected before further testing can continue.

TEST B

If the previous test is satisfactory, press the POINTS RESISTANCE switch and observe the reading on the meter.

If the needle reads in the "GOOD" area, the voltage loss or resistance in the circuit can be considered acceptable.

TROUBLE SHOOTING

The sequence outlined below is applicable to searching for an open circuit or for excessive voltage loss.

In the case of an open circuit, the lead which has just been passed when the needle reads zero is the one causing the open circuit.

If the reading is in the "BAD" area with switch depressed, take the BREAKER POINTS lead and attach it to the point where the low tension lead from the coil joins the distributor.

Press the switch again and observe the reading. If the needle should now read in the "GOOD" area, it proves that the lead which has just been passed has a fault causing high resistance, such as frayed wire, loose terminals, etc.

Should the second test make no appreciable difference in the meter reading, checking must be continued to the next wire or joint in sequence until the component or wire which has just been passed brings the needle into the "GOOD" zone. This, then, is the wire which must be renewed or the joint cleaned and tightened.

It should be appreciated that in the checking sequence, each succeeding check will show a slight drop in the reading which is quite normal. A wire or joint showing a high voltage drop needs correction.

An ultimate reading of zero should be obtained when the lead is attached to the body of the distributor.

Should this reading not be obtained, it indicates that dirt, oil, or paint between the distributor body and the engine block is preventing proper contact thereby causing a resistance in the primary circuit.

Fig. 9. Sequence of Check Points.

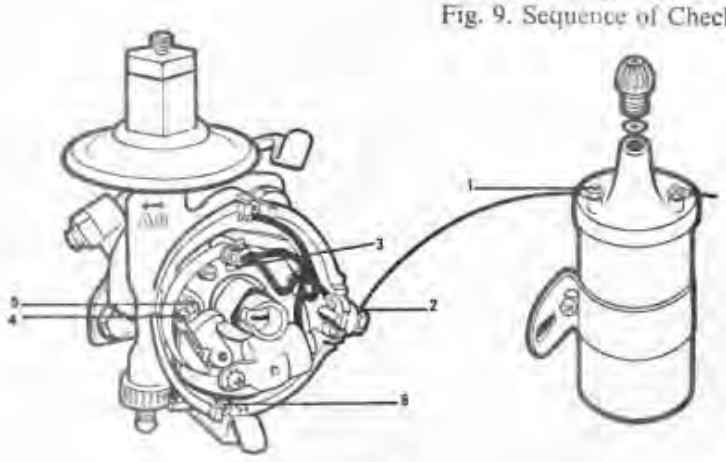


Figure 9

CHARGING SYSTEM

MAIN SWITCH IN CHARGING SYSTEM POSITION

The object of this test is to determine whether the generator or alternator in conjunction with the regulator is capable of maintaining the battery in a correct state of charge.

The engine should be at normal operating temperature to ensure that the regulator and generator/alternator temperatures have normalised.

A cold regulator may give rise to incorrect readings.

TEST

Check fan belt for correct tension.

Check generator/alternator and regulator terminals for cleanliness and security.

Start the engine and run it at approximately 1500-1800 r.p.m.

The needle on the voltmeter should gradually rise and the readings may be taken from the appropriate voltage scale.

'SCOPE PRESENTATION

N.B.: THIS PATTERN IS ONLY APPLICABLE TO ALTERNATORS.

The pattern Selector Switch is placed in the alternator position and a pattern of the "charging ripple" is presented. This pattern may be increased by adjustment of the SIZE control for better viewing.

The pattern represents the rectified current actually entering the battery. The illustrations represent good and bad alternators.

The point at which the regulator functions is indicated by the voltmeter needle slowly reaching a position at which it will be seen to fluctuate slightly.

This slight fluctuation of the voltmeter needle will continue and is indicative that the internal voltage of the battery is equal to the potential of the charging system.

In the absence of specific vehicle settings, the readings should be within the following:

6V System:	**Min. 7.V.**	**Max. 7.4V.**
12V System:		
Generator:	**Min. 13.8V.**	**Max. 14.5V.**
Alternator:	**Min. 13.5V.**	**Max. 14.2V.**

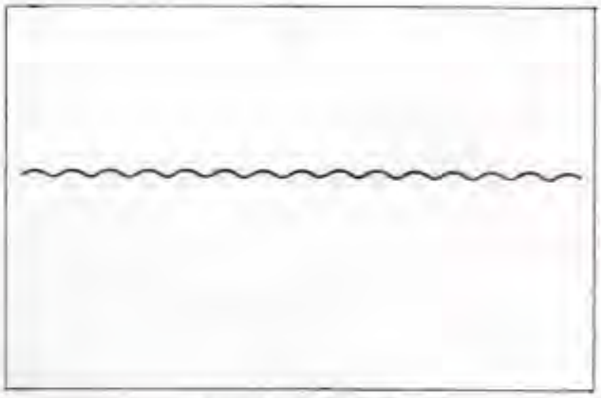
It must be understood that if the battery is in a low state of charge (shown on voltmeter scale with engine stopped), a lengthy period of running will be necessary before the fluctuation of the voltmeter needle, indicating regulation point, occurs.

The correct setting of the charging circuit cannot be emphasised enough because of its bearing on ignition system output, contact points, battery and headlight globe life, etc.

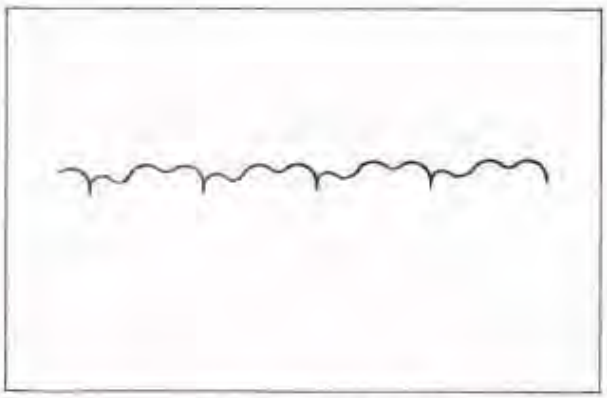
Should the test denote an apparent malfunction of the system, it is strongly advised that the actual setting or correction be carried out by an auto electrician as it is very easy to cause expensive damage if incorrect settings are made

This switch position also allows the ammeter to be used for checking generators.

The connection for the shunt and lead are described in the section "CONNECTING THE LEADS".



GOOD ALTERNATOR



FAULTY ALTERNATOR DIODE

FIFTH AREA

DISTRIBUTOR POINT ADJUSTMENT AND DISTRIBUTOR OPERATION

MAIN SWITCH IN DWELL ANGLE POSITION

The object of this test is to determine whether:

A. Distributor Points are set to the correct specifications.

B. Distributor is within acceptable limits of wear.

TEST A

With engine running at idle speed, check the meter and observe the reading on the appropriate DWELL ANGLE scale for the correct number of cylinders.

It should be noted that these particular scales read from RIGHT to LEFT.

Should the points require adjustment, this may be done by removing the distributor cap and rotor button and slackening the lock screw on the earth point.

With the ignition switch ON, turn the engine with the starter.

Any movement of adjusting screw will alter the meter reading and when the correct reading is obtained stop the starter and tighten the lock screw.

Check reading again as it will be found that the tightening of the lock screw sometimes alters the setting

This operation may require a little practice until the various operations are co-ordinated, but once this is achieved it represents a fast and accurate method of adjusting Dwell Angle.

It will also be found that the reading obtained at cranking speed is generally 1° — 2° higher than that shown at idling speed and for this reason it is advised that if the specifications call for say 38°, the adjustment should be made at 39° — 40° at cranking speed.

When fitting new points, always set on the lowest limit of the specifications or if a set figure is given, the points should be set about 2° lower.

Setting at the lower limit means that the points are wider apart than they should be, but with new points the rubbing block will wear and allow the points to come closer which increases the Dwell Angle to the correct figure.

TEST B

With the engine running at idle speed, again observe the reading and accelerate engine to approx. 2000 r.p.m.

The variation of dwell reading on the meter should not exceed 3°.

If the variation is above this figure, disconnect the line from the vacuum unit of the distributor and repeat the test.

Should the reading then stabilise it indicates that the point-bearing plate in the distributor is loose on its mountings and is being pulled off-centre by the action of the vacuum unit.

If, however, disconnecting the vacuum line causes no change in the reading, the indication is that the distributor shaft bushings are worn, or distributor shaft bent allowing the distributor cam to run out of true. This in turn affects the dwell reading and point gap.

One exception to the "Steady reading" rule is a type of distributor in which the point bearing plate is pivoted "off-centre" and then the action of the vacuum unit pulls the plate eccentrically. The variation in this instance is a drop of 6° — 7°.

Readings exceeding this limit should be investigated and the fault rectified.

SIXTH AREA

INITIAL IGNITION TIMING AND ADVANCE CURVE

MAIN SWITCH IN "TIMING ADVANCE" POSITION

The objects of this test are to:

A. Check, and if necessary, re-set initial ignition timing.

B. Check amount of advance obtained from distributor centrifugal weights.

C. Check amount of advance obtained from distributor vacuum unit.

TWO PARAMOUNT RULES MUST BE OBSERVED WHEN USING THIS CIRCUIT.

1. Any change of engine speed must be compensated for by re-adjustment of the TIMING ADVANCE control to re-align the timing marks.
2. If the advance circuit has been used to set initial timing, this initial timing figure must be subtracted from the reading obtained when checking the amount of centrifugal advance.
   E.g. Initial Timing 5° B.T.D.C. at 500 r.p.m.:
   5° showing on meter, with nick on pulley in line with T.D.C. pointer.
   Intermediate Centrifugal Advance Check:
   17° showing on meter at 1500 r.p.m. with nick on pulley in line with T.D.C. pointer. = actual Centrifugal advance of 12°.

TEST A

DISCONNECT AND PLUG VACUUM UNIT LINE.

Firstly, ascertain whether the engine has an actual TIMING MARK or a T.D.C. MARK.

Should it be a TIMING MARK, this sequence should be followed:

1. Make sure that TIMING ADVANCE control is in TIMING position. (The light flash is now instantaneous with No. 1 plug firing.)
2. Check idling r.p.m. (To ensure that no "weight-throw" can indicate a false reading.)
3. Check with light for alignment of MARK with POINTER. Re-adjust as required.

Should the engine have a T.D.C. REFERENCE, this sequence should be as follows:

1. Check vehicle specifications for correct settings.
2. Check idling r.p.m.
3. Rotate TIMING ADVANCE control clockwise until the needle on the advance meter indicates the required number of engine degrees (obtained from specifications) on the advance scale.

NOTE: Actuating the control delays or holds the signal from No. 1 plug for a brief period before the flash occurs, consequently the stroboscopic action takes place later so that the marks "line-up". The engine degrees through which the crankshaft travels during this delay period are shown on the meter.

This is a very accurate measurement, and is to be trusted more than mass produced stamped flywheel or pulley scales.

4. If the timing is correctly set, the reference "nick" on the pulley or flywheel should appear in line with the T.D.C. Mark.
   If it is necessary to re-set the timing, the r.p.m. could either increase or decrease in which case attention is drawn to PARAMOUNT RULE 1 at the beginning of this section.

NOTE: Should any doubt exist concerning the accuracy of the timing marks, a quick check may be made by connecting the vacuum gauge into the inlet manifold. The reading so obtained can be checked against the page on vacuum gauge readings. If a discrepancy is apparent, it will then be necessary to remove No. 1 plug and check the piston top centre position in relation to the timing marks.

Vehicles which are normally operated above sea-level may with advantage, be set 1-1½ degrees advanced on specifications for every 1000 ft. of altitude. Naturally a vehicle so set, when brought down to sea-level has a tendency to "ping".

TEST B

VACUUM LINE STILL DISCONNECTED

As a quick check on centrifugal advance, rotate TIMING ADVANCE control to timing to make the advance circuit inoperative.

With the light directed at the timing marks gradually accelerate engine to about 2000 r.p.m. The "nick" on the pulley should move gradually away from the pointer.

If this movement is erratic, refer to TROUBLE SHOOTING for possible causes.

To check the advance curve, determine specifications which will give a number of degrees of advance at certain r.p.m.

When checking these figures, make certain that they are ENGINE DEGREES and ENGINE R.P.M.

A number of specifications are shown in DISTRIBUTOR DEGREES and DISTRIBUTOR R.P.M., in which case both figures will need to be doubled to obtain engine degrees.

Having ascertained these figures correctly, set the throttle to required engine r.p.m., and using the TIMING ADVANCE control, bring the "nick" on the pulley in line with the T.D.C. mark.

Without altering the engine speed, check the reading on the advance scale and compare with the specifications making sure to subtract the initial setting degrees as previously mentioned.

It has been found that for most practical purposes, if the readings are correct for the start and intermediate portions of the curve, the final reading may be accepted as being within limits.

This obviates the necessity of running an engine at high revs. without load, which is a most undesirable and a potentially expensive practice. If it is suspected that the curve on the upper range is incorrect, this should be checked on a Distributorgraph.

TEST C

Vacuum advance specifications are generally given as so many degrees (watch for distributor or engine) at a certain number of inches of mercury. This is often expressed as 12° — 10". Correctly written it should be 12° at 10 ins. Hg.

Having noted the specifications, the following is the procedure.

1. Connect the vacuum gauge to the now unplugged vacuum unit line.
2. Gradually increase the engine revolutions until the correct vacuum reading is shown on the gauge.
3. Note r.p.m. at which this reading is obtained.
4. Check the amount of centrifugal advance obtained at r.p.m. noted in 3, by again lining up the timing marks using the TIMING ADVANCE control.
5. Re-connect the vacuum line to the distributor vacuum unit.
6. Adjust the throttle to obtain the same r.p.m. readings as in 3.
7. Re-align the timing marks, and note the reading on the scale.
8. Subtract the reading obtained in 4 from the reading in 7, the difference being the amount of advance given by the vacuum unit.

NOTE: It should be noted that the foregoing must necessarily apply to a conventional distributor. Vehicles fitted with a vacuum control as the sole means of advance, can only have their advance curve properly checked out on a distributograph fitted with a manometer (10 in. column of mercury graduated in .1 in. steps). They can, however, be checked for advance by connecting the vacuum line and proceeding as outlined at the commencement of TEST B.

TROUBLE SHOOTING

Symptom	Possible Cause	Symptom	Possible Cause
Initial timing erratic, or unstable at idling.	Broken or weak springs on centrifugal weights. Worn timing chain or gear allowing excessive lash. Sloppy or worn centrifugal weights or toggles.	No increase in advance after re-connecting vacuum line.	Port or valve in carburettor blocked. Faulty vacuum unit. Point bearing plate seized. Blocked or broken vacuum line.
Timing marks not moving smoothly apart when engine speed is increased.	Centrifugal weights seized or having weak springs. Distributor cam frozen on shaft.	Timing light flashing intermittently.	Low coil output. High resistance in secondary circuit. Excessive rotor gap.
Different reading of initial timing after revving engine.	Weights or cam partially frozen, not returning properly. Weak springs.	Not sufficient advance at a given engine speed.	Centrifugal spring tension too strong (incorrect springs or tension incorrectly adjusted).
		Too much advance at a given engine speed.	Centrifugal spring tension too weak.

SEVENTH AREA

COMPLETE IGNITION CIRCUIT CHECK

MAIN SWITCH IN "IGNITION ANALYSIS" POSITION

N.B. Ensure that ignition advance control is in "TIMING" position.

The objects of this test are to:

A. Analyse ignition circuit operation.

B. Check high tension voltages.

GENERAL

The following procedure is recommended for the operation of this portion of the instrument, but it is realised that the operator may prefer to adopt his own methods after he gains experience in the diagnosis of various faults and abnormal conditions.

This MAIN SWITCH position, in conjunction with the patterns available on the PATTERN SELECTOR switch, is particularly useful for load testing on a dynamometer. Any malfunction at varying speeds or loads will show on the screen thus minimising diagnosis time. Again, the use to which this is put will depend on experience.

Normal testing sequence is followed by using the "PATTERN SELECTOR" switch in a clock-wise direction. As each pattern is presented on the screen it should be checked for any discrepancies. Should none be apparent, turn switch to next position and check again.

Any irregularities which show up on a pattern may be diagnosed by reference to the patterns in the succeeding pages. If the specific pattern showing on the screen is not duplicated in the book, the fault may be diagnosed by reference to the particular section and working from the pattern which most closely resembles the one on the screen.

It will be found that very little practise is needed to recognise the more common faults and as experience is gained, reference to the book will be less and less. Faults should be classed also as "common to all cylinders" or an "individual cylinder fault", this practise will also speed diagnosis time.

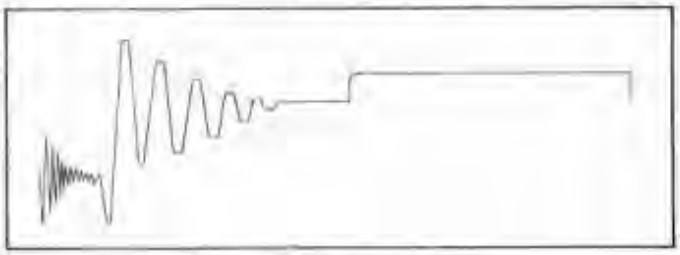
PATTERN SELECTOR IN "PRIMARY" POSITION

ENGINE SHOULD BE RUNNING AT APPROXIMATELY 1,500 R.P.M. FOR BEST VIEWING.

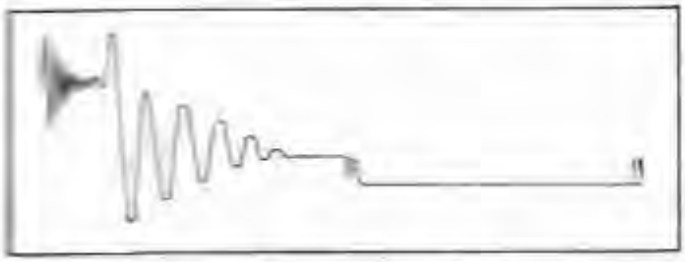
This pattern is a "Superimposed" presentation of the primary voltages and oscillations for all cylinders. The pattern should be positioned centrally on the screen using the controls as detailed in "INSTRUMENT FAMILIARISATION".

The illustrations show correct traces for negative and positive battery earth polarity.

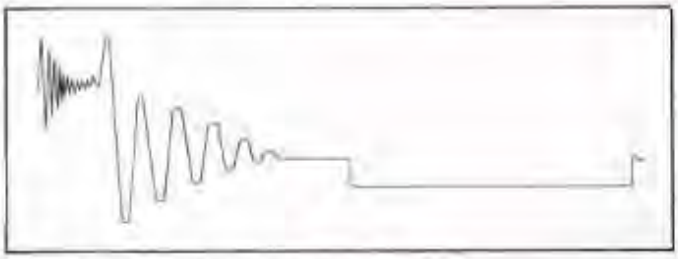
NEGATIVE GROUND



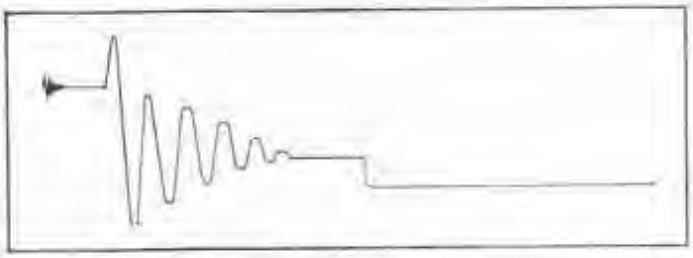
POSITIVE GROUND



Horizontal spacing of lines at Points Open and Points Close signals indicating distributor cam variation. A maximum of $\frac{1}{2}°$ is allowable.



Condenser — Series Resistance.
A leaking condenser will reduce the amplitude of the oscillations.



Some types of ballast-resistor ignition systems will show a marked decrease in the amplitude of the first oscillations due to the damping effect of the ballast. This should not be confused with a leaky condenser which tends to decrease all oscillations.

PATTERN SELECTOR IN "SECONDARY" POSITION

This pattern when suitably adjusted gives a full width trace for each individual cylinder, this procedure being outlined in "INSTRUMENT FAMILIARISATION".

Reference to the BASIC WAVE FORM — Fig. 16 will indicate that it is divided into three main sections.

SPARK LINE SECTION. Irregularities in this section are caused by a fault in the secondary circuit. The length of this line is indicative of spark duration or time of spark across the spark plug gap. Any suppression in this circuit will shorten the SPARK LINE in other words the duration is shortened. Other factors which shorten the line are excessive rotor gap, badly fitted plug terminals or corrosion where H.T. leads push into distributor cap. Again, ascertain whether the fault is common to all cylinders or affects one cylinder only.

COIL and CONDENSER SECTION. The oscillations immediately following the spark line are the charge and discharge wave forms of the condenser. Five "wiggles" should be regarded as a minimum, most modern high output ignition systems have from eight to twelve. It is also desirable that at 1500 R.P.M. the oscillations finish before the POINTS CLOSE SIGNAL.

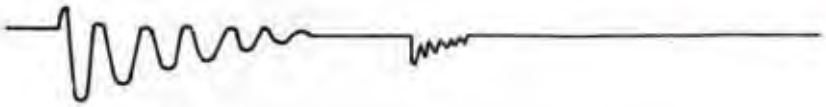
IMPORTANT. The POINTS CLOSE signal must always project UPWARDS from the base line irrespective of the battery earth polarity. If it does not the COIL PRIMARY is connected incorrectly and the leads must be reversed.

If the primary oscillations continue into this signal it means that there will be arcing as the points come together which is not conducive to long point life. The factor is impossible to correct at higher speeds as the condenser works at a fixed speed. However, it may be alleviated if dwell angle is lessened by a REASONABLE amount (2—3 degrees below lower specification limit) so that at 1500 R.P.M. the oscillations have been dissipated before the "POINTS CLOSE" signal.

DWELL ANGLE SECTION. Begins at the POINTS CLOSE signal and continues to the end of the trace which is the POINTS OPEN signal. During this time current is flowing in the primary circuit, any loose connection in the primary circuit will show as an interruption in this section. A bent distributor shaft or the cam lobes badly ground, points misaligned, etc., all show very clearly.

NORMAL WAVE-FORM

LOW TENSION CIRCUIT SYMPTOMS

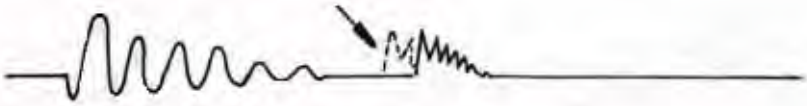


Pattern up-side-down, reversed polarity. Caused by incorrect connection of primary wires on coil, battery incorrectly installed or coil wired wrongly internally.

Interruption of first trace on Points Close signal indicates mis-aligned points. Tail at Points Open signal indicates arcing as points break. Charging rate set too high, wrong coil or faulty condenser.

Low and rounded Points Close signal indicates points burnt.

Intermittent horizontal movement of Points Close signal indicates breaker plate loose or moving point loose on pivot.



SPARK LINE SYMPTOMS

LONG SPARK LINE. Showing decrease in primary oscillations, indicating less residual coil energy.
All Traces. Incorrect coil. Shorted coil primary turns. Charging rate set too high. If ballast resistor system — defective ignition switch.
Single Trace. Spark plug oiled, shorted or gap too small. Plug H.T. lead grounded. Low compression.

SHORT SPARK LINE. Showing increase in primary oscillations, indicating more residual coil energy.
All Traces. H.T. lead from coil not bottomed in distributor cap. Defective suppressor-type H.T. lead from coil to dist. Faulty in-line radio suppressor. Charging rate set too low. Excessive rotor gap. Deposit on dist. cap segments. Ignition timing incorrectly set. Weak mixture or leaking inlet manifold.
Single Trace. Defective suppressor-type H.T. lead. H.T. lead not bottomed in dist. cap or poor connection at plug. Plug gap too wide

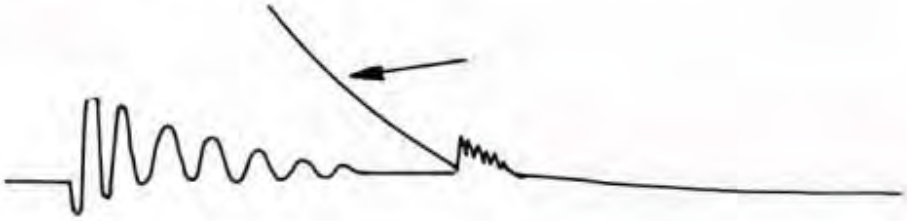
NO SPARK LINE. Showing large increase in primary oscillations. Still possible for engine to run but would miss under load.
All Traces. Coil/Dist. H.T. lead open-circuit or not bottomed in dist. cap.
Single Trace. Plug H.T. lead not bottomed in dist. Open circuit plug lead. Very wide plug gap.

SLOPING SPARK LINE. May be up or down and is caused by high resistance in H.T. circuit, may be one or all traces depending on whether it is a plug lead or H.T. coil/dist. Resistance rotor, resistance plug terminals or corrosion at H.T. lead ends.

SPARKLINE SYMPTOMS

Defective ignition coil indicated by short spark line and lack of primary oscillations. Same effect can be caused by some tachos connected across coil primary. Check this before condemning coil.

Intermittent line flicking up from points close signal is indicative of poor insulation on H.T. leads. If leads can be separated symptom should disappear.



PATTERN SELECTOR AT 20 K.V.

Switching to this position will display a series of vertical traces; manipulate the controls so that the heavy horizontal base line is in line with the zero line of the K.V. scales. The traces are then read in line with the left hand vertical scale. The pulses read from left to right in firing order with No. 1 being the first trace on the left. These traces are a measure of the actual voltage necessary to "break-down" the spark plug gap and promote a conductive path.

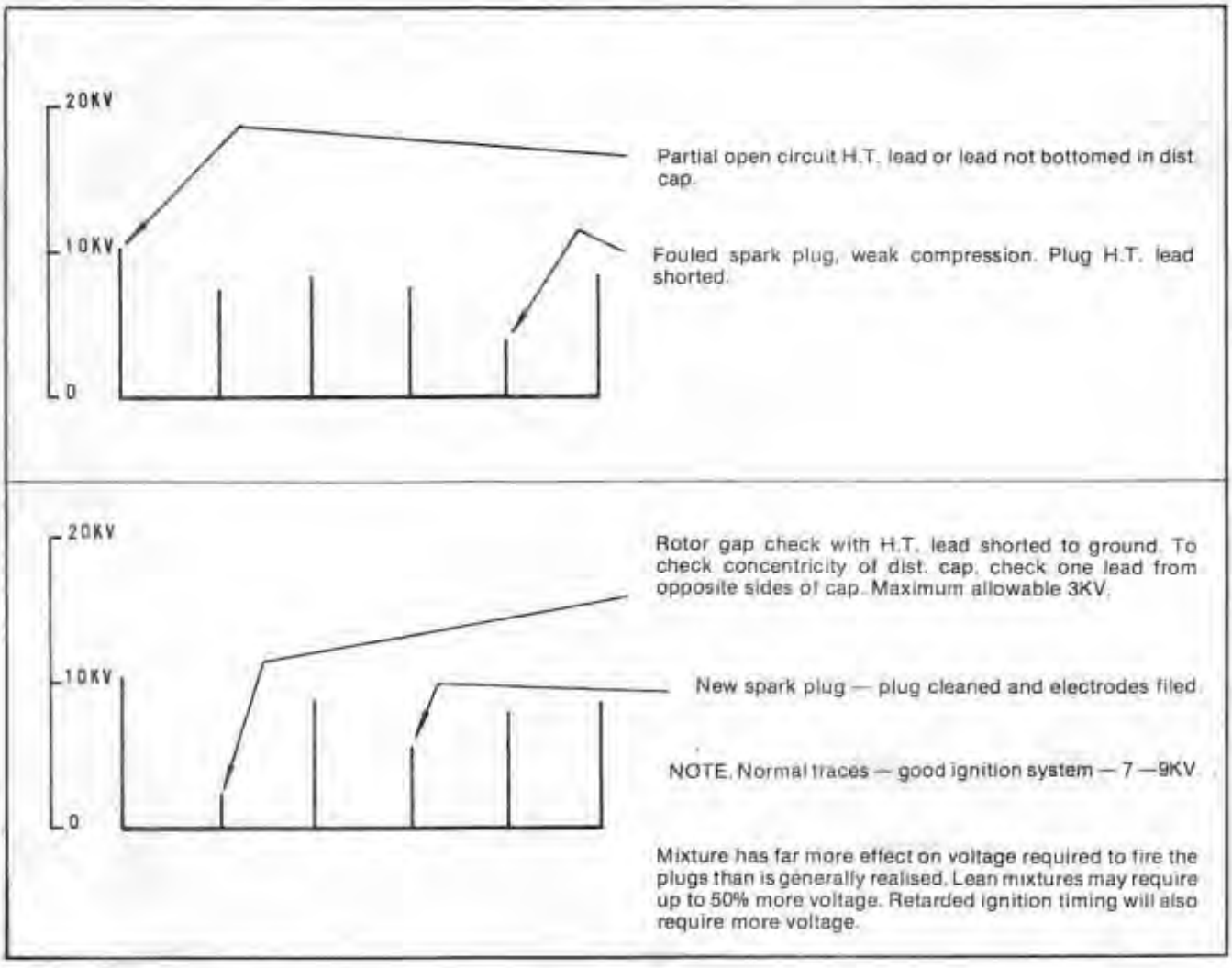
It will be seen, therefore, that the shorter these traces are the less voltage is required, which means that the coil has more reserve to meet heavy voltage demands such as heavy low speed pulling or hard acceleration. This is also the direct opposite of the length of SPARK LINE in the SECONDARY presentation where a long line is desirable.

IN ESSENCE THE SPARK LINE REPRESENTS TIME AND THE VOLTAGE TRACE REPRESENTS VOLTAGE REQUIRED.

Normally the VOLTAGE traces should not exceed 7—8 K.V. — with new plugs fitted and with the H.T. circuit in good condition the reading could well be as low as 5 K.V.

Rotor gap is also checked in this PATTERN SELECTOR SWITCH position and may be found by removing any spark plug lead and shorting it directly to earth. The resulting trace should not exceed 3 K.V. this measurement being the VOLTAGE REQUIRED to jump the gap from the rotor blade to the distributor cap plus any resistance in the H.T. lead.

20 K.V. RANGE

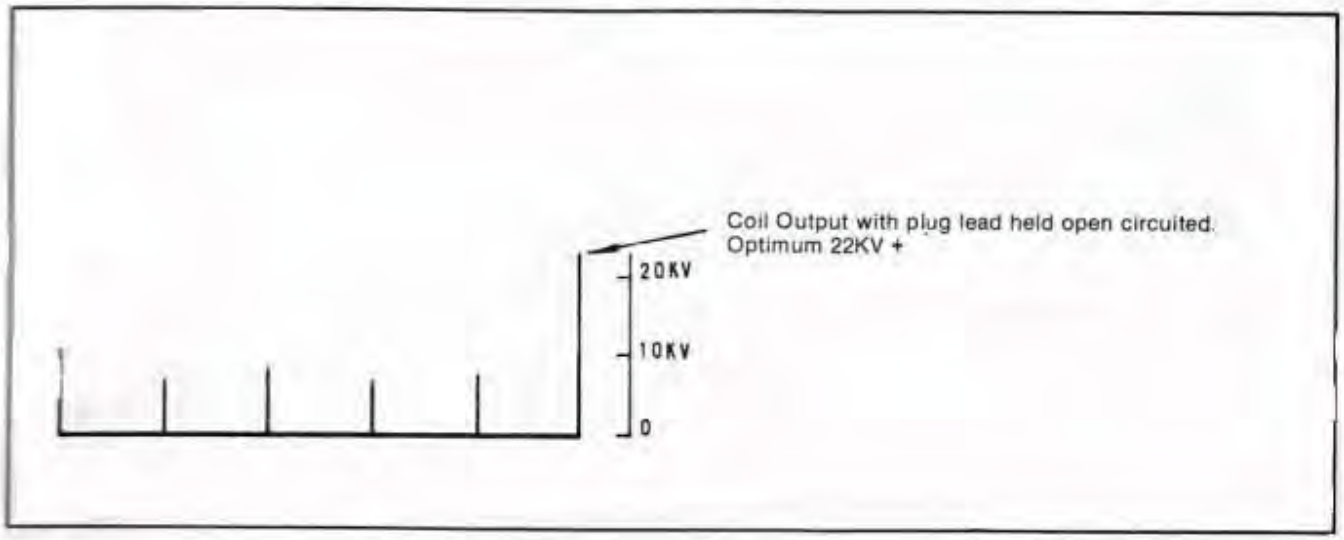


PATTERN SELECTOR AT 40 K.V.

This position also displays vertical traces in the same order as those in the previous position, but it will be noted that they are half the length and also they are read against the right hand vertical scale.

The main purpose of this display is to check the full output of the coil. To obtain this reading any spark lead is lifted from the plug and held clear so it will not spark against the block or any other metal part. A trace will be seen which is much longer than the others and which is measured against the right hand scale. For adequate ignition reserve this coil output pulse should be approximately three times the plug firing voltage which was ascertained in the 20 K.V. SWITCH POSITION.

40 K.V. RANGE



EIGHTH AREA

CARBURATION AND FUEL PUMP

N.B. It cannot be too highly stressed that before attempting any work on the carburettor/s the ignition system must be set to correct specifications and all faults rectified. It is for this reason that this check is placed last in the tuning sequence

MAIN SWITCH IN IGNITION ANALYSIS POSITION

The object of this test is to:

1. Check the AIR-FUEL RATIO being supplied to the cylinders.
2. Check the efficiency of the air cleaner.

Readings from multiple carburettors will show an overall result if the exhaust is fed into a single pipe.

Only when an individual carburettor feeds certain cylinders and these particular cylinders have a separate exhaust system is it possible to check this carburettor in a multiple installation.

To correctly set multiples on an engine using a single exhaust it is necessary to make sure all float levels, jets and other calibrations are exactly the same, so the overall result from the single exhaust will be applicable to all carburettors.

N.B. ANY AIR LEAKS IN THE VEHICLE EXHAUST SYSTEM WILL GIVE FALSE READINGS.

It will have been noticed that the Air/Fuel Ratio Meter is active in all switch positions. At this point by moving the control labelled BALANCE (to the right of timing light plug) the needle is brought over the BALANCE LINE on the meter scale. The Sampling Hose is then inserted into the vehicle's exhaust pipe as far as possible and securely clamped. The other end is pushed onto the long pipe at the rear of the instrument.

Test for 1.

A. IDLE MIXTURE. Allow engine, which must be at normal operating temperature, to idle at the specified R.P.M. and check the reading.
The needle should indicate between 13.2 and 13.5.

N.B. This reading applies to later model vehicles fitted with P.C.V. systems. Earlier model vehicles should read around 12.5.

Turning the mixture screw in (on most carburettors) will lean the mixture and 1/8th of a turn will affect the reading quite considerably.

With dual or multiples, these screws should be lightly seated and both turned out an equal amount. Any further adjustments should also be equal. When setting idle mixture, remember that the gas flow in the exhaust is comparatively slow, so after alteration of setting allow, say, 30 seconds for reading to stabilize.

B. CRUISING MIXTURE. Increase engine speed to 2,000 R.P.M. and note reading when needle steadies. This should be between 13.5 and 14.

C. HIGH SPEED MIXTURE. Increase engine speed further to 3,000 R.P.M. and note reading when needle steadies. This should be between 14 and 14.5.

Test for 2. After noting the reading in B, remove the air cleaner and repeat the test.

A .5 variation in the reading should be considered maximum. Should the reading exceed this figure the element of the air cleaner should be replaced.

FUEL PUMP OPERATION

With the engine stopped open the fuel line between the pump and carburettor at the carburettor or fuel pump. Connect the vacuum gauge hose to the fuel pump outlet and start the engine (there will be sufficient fuel in the carburettor bowl for a short period). The fuel pressure should rise to the correct figure for the pump. Read the pressure on the FUEL PRESSURE scale on the gauge. Stop the engine and the pressure should remain for at least 20 seconds. Reconnect the pump and carburettor.

High fuel pump pressure should not be overlooked as cause of excessive fuel consumption. Always check this before attempting to vary main jet sizes or set float level down from that which is specified.

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